

Appendix T



Field Verification Protocol for Determining Reduction in Infiltration Levels and Mechanical Ventilation Requirements for Site Built and Mobile Homes with Verified Air Sealing

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Scope: This Appendix describes the blower door test protocol for testing the air-leakage of site built single family houses and manufactured/mobile homes to determine the reduction in air infiltration level achieved by air sealing measures. It also sets out the minimum mechanical ventilation system requirements that must be met whenever house-tightening measures are installed.

1.0	TESTING PROTOCOL.....	142
1.1	When to Test:.....	142
1.2	House/Residence Preparation:	142
1.3	Equipment Set-up:	143
1.4	Performing the Test: Perform the test using the following procedures:.....	143
1.5	Computing Air Leakage Reduction:	143
1.6	Estimate Annual Energy Savings and C&R Discount Credit:.....	144
2.0	MECHANICAL VENTILATION REQUIREMENTS	144
2.1	Mechanical Ventilation.....	144
2.2	Unbalanced Non-Heat-Recovery Ventilation-Continuous Operation	146
2.3	Balanced Flow Non-Heat Recovery Ventilation-Continuous Operation	146
2.4	Air-to-Air Heat Exchangers.....	147
2.5	Other Mechanical Ventilation Systems	147

1.0 TESTING PROTOCOL

1.1 When to Test:

1.1.1 New construction -

Testing shall occur after everything is roughed-in/ installed that will penetrate the building envelope (e.g., plumbing, electrical, HVAC, ventilation, combustion appliances, etc.) and the air barrier has been installed.

1.1.2 Existing construction -

Testing shall occur immediately prior to the installation of any air leakage control measures. Post-installation testing shall occur immediately following the installation of air leakage control measures.

1.1.3 Test conditions -

Testing shall not be done when the outside wind speed exceeds 15-20 miles per hour.

1.2 House/Residence Preparation:

All single family houses and manufactured/mobile homes shall be checked before testing to assure that following preparation measures have been completed.

1.2.1 Building envelope:

All windows and doors shall be properly closed, including pass-through wood-box doors and pet doors. All interior doors shall be left open.

1.2.2 Ventilation openings:

All exhaust fan openings, vent openings, and intake-air vents with backdraft dampers (e.g., dryer vents and kitchen, bathroom, utility room, whole-house, range vents, etc.) shall NOT be sealed.

Exterior vent openings without backdraft dampers (e.g., some continuous ventilation systems) shall be temporarily sealed for the test. Heat recovery ventilator supply openings shall be sealed. Heat recovery ventilator exhaust openings should have backdraft dampers and shall not be sealed.

1.2.3 Forced-air heating systems:

Supply and return registers shall NOT be sealed and the heating system shall be turned off. HVAC ducts shall be tested with the envelope. Dampers in the outside-air supply duct into the return plenum shall be closed.

1.2.4 Combustion appliances:

All flue dampers, fireplace doors, and wood burning stove doors shall be closed, but NOT sealed.

1.3 Equipment Set-up:

The blower door equipment shall be set-up using the following procedure:

1.3.1 Gauge temperature

Keep the gauges at room temperature if possible. Cold temperatures may affect gauge accuracy.

1.3.2. Blower door

Install the blower-door assembly according to manufacturer's instructions.

1.3.3. Set up the gauge assembly with the gauges plumb and level. This procedure is not required for digital gauges.

1.3.4. Attach a hose to the indoor pressure tap. Place the free end of the hose indoors away from the fan airflow path at the approximate height of the fan centerline. If using a digital gauge, run a hose outside through the blower door shroud; make sure the end of the hose is not in the air stream of the blower door. Use of a static pressure tap is recommended.

1.3.5. Exercise the gauges by blowing and sucking on the hoses to drive the gauges over their entire range six to eight times. Install the fan orifice plate, plug or seal all holes, and adjust the gauges to zero. This procedure is not required for digital gauges.

1.3.6. Start the fan and depressurize the house to check for anomalies in the building envelope.

1.4 Performing the Test: Perform the test using the following procedures:

1.4.1. Depressurize the house to 55 Pascals and reduce the pressure to 50 Pascals (0.205 inches of water).

1.4.2. Tap the gauge to reduce stored spring energy from the gauge needle and wait for the needle to stabilize before recording the readings. This procedure is not required for digital gauges.

1.4.3 View the gauge from directly in front when taking a reading. Maintain a consistent line of sight to avoid parallel errors or distortions from the gauge cover. This procedure is not required for digital gauges.

1.4.4. Increase the pressure again and then retest at 50 Pascals.

1.5 Computing Air Leakage Reduction:

1.5.1 Calculate the ACH @ 50 Pascals (ACH_{50pre}) prior to installation of air sealing measures and divide this value by 20 to estimate the average annual infiltration rate (ACH_{avg}).

- 1.5.2 Calculate the ACH @ 50 Pascals (ACH50post) after installation of air sealing measures and divide this value by 20 to estimate the average annual infiltration rate (ACHavg).
- 1.5.3 Subtract the value obtained in step 5.2 from that obtained in step 5.1 to determine the reduction in annual infiltration rate achieved. Round this value to the nearest 0.1 ACH.
- 1.6 Estimate Annual Energy Savings and C&R Discount Credit:
 - 1.6.1 To compute the annual energy savings multiply the estimated reduction in annual infiltration rate times the homes floor area times the value in Table 1 for the appropriate building type and climate zone.

Table 1 - Annual Energy Savings			
(kWh/sq.ft./0.1 ACH change)			
Building Type	Zone 1	Zone 2	Zone 3
Mobile/Manufactured Homes	0.62	0.80	0.94
Site Built Homes	0.2	0.32	0.37

- 1.6.2 To compute the C&R Discount Credit multiply the estimated annual energy savings obtained in Step 6.1 times the value in Table 2 for the appropriate building type and climate zone.

Table 2 - Conservation and Renewable Rate Discount Credit			
(\$/kWh saved)			
Building Type	Zone 1	Zone 2	Zone 3
Mobile/Manufactured Homes	\$ 0.39	\$ 0.39	\$ 0.39
Site Built Homes	\$ 0.50	\$ 0.50	\$ 0.50

2.0 - MECHANICAL VENTILATION REQUIREMENTS

2.1 Mechanical Ventilation

A mechanical ventilation system meeting either the requirements of 2.1.1, 2.2, 2.3 or 2.4 shall be installed in all homes that have reductions in air leakage rates verified through this protocol.

2.1.1 Non-Heat-Recovery Ventilation - Intermittent Operation

- 2.1.1.1 A bathroom exhaust fan is controlled by both a manual switch, crank timer or dehumidistat in the bathroom to provide spot ventilation AND a time clock to provide whole-house ventilation when called for by the timer. Outside-air inlets in all living areas and bedrooms, and undercut doors, grilles, transoms,

or other approved means provide fresh-air circulation through the house to the bath fan.

2.1.1.2 Exhaust ducts shall be smooth metal and terminate outside the house at the closest possible location. All connections shall be tight fitting and taped or sealed, and backdraft dampers shall be provided.

2.1.1.3 The minimum exhaust airflow rates shall comply with either the performance OR prescriptive paths listed below. Surface-mounted fans shall have a sone rating of 1.5 or less, or other rating as approved by the Utility. Existing fans that meet the minimum airflow rates are exempt from the sone rating requirement.

2.1.1.3.1. **Performance Path:** The minimum measured airflow capacity shall be either 0.35 air-changes per hour (ACH) or those listed below:

Number of Bedrooms	Measured Exhaust Flow
1	45 cfm
2	60 cfm
3	75 cfm
4	90 cfm

To calculate the ACH for a fan with a MEASURED airflow of 45cfm multiply by 60 to obtain the airflow per hour (45 X 60 = 2700 cfh) and divide by the volume of the heated space.

2.1.1.3.2 **Prescriptive Path:** Ventilation systems that do not meet the performance path shall provide 0.35 ACH based upon the rated fan flow minus 15 cfm or use the rated fan flows in the following table:

Number of Bedrooms	Rated Fan Flow
1	70 cfm
2	85 cfm
3	100 cfm
4	115 cfm

To calculate ACH based on the RATED airflow, subtract 15 cfm, multiply by 60, and divide by the volume of the heated space.

2.1.1.4 The fan shall have both automatic and manual controls. Automatic controls shall include a time clock or cycle timers with a minimum of 2 on-periods per day, a manual control switch to let the occupant turn the fan on or off, and be set to operate a minimum of 8 hours per day.

2.1.1.5 The ventilation fan shall be wired to both the manual spot-ventilation switch in the bathroom and to a time clock.

- 2.1.1.6 Individual outside-air inlets, located to avoid drafts, shall provide a minimum of 4 sq. inches per bedroom and combined living area.

If a whole house blower door test, in accordance with Appendix T and conducted after air sealing measures are installed, results in an $ACH_{50} \div 20$ greater than 0.35 and the house has no combustion appliances capable of backdrafting (i.e. naturally vented or atmospheric chimneys) within the exterior shell of the house, the outside-air inlets may be omitted.

- 2.1.1.7 The outside-air source shall be located at least 3 feet from exhaust vents and to minimize drawing outdoor pollutants and excessive outdoor noise inside during operation.

- 2.1.1.8 The outside-air source shall limit excessive airflows during normal operation and have a weather protection hood and maximum 1/4" screen-mesh, or as approved.

2.2 Unbalanced Non-Heat-Recovery Ventilation-Continuous Operation

- 2.2.1 This system uses a continuously-operating fan to exhaust air at a minimum rate of 25 cfm for the kitchen, and 20 cfm for each bathroom, with a maximum rate of 0.5 ACH. One fan exhausting from the kitchen and each bathroom also provides spot ventilation. An integrated spot and whole-house fan is acceptable if spot ventilation is also provided for the kitchen and for the bathrooms.
- 2.2.2 The exhaust-air pickup in the kitchen shall not be over the kitchen range.
- 2.2.3 If the exhaust flow from each kitchen and bathroom is not measured, the rated fan capacity shall exceed the required flow rate by a minimum of 15 cfm.
- 2.2.4 The continuous ventilation fan(s) shall be wired to an existing circuit or to the electrical service panel.
- 2.2.5 The outside-air inlet and source requirements shall be the same as Sections 2.1.1.6, 2.1.1.7 and 2.1.1.8.

2.3 Balanced Flow Non-Heat Recovery Ventilation-Continuous Operation

- 2.3.1 Balanced flow non-heat-recovery air exchange units shall:
- 2.3.1.1 have fans capable of providing the intake and exhaust airflow rates in section 2.1.1.3 at 0-25 inches of water gauge as determined by HVI 916 (July 1993);
 - 2.3.1.2 provide complete isolation of the intake and exhaust air;
 - 2.3.1.3 have UL approval of all electrical components;
 - 2.3.1.4 have outside-air inlets in all living areas and bedrooms, positioned so-as-to avoid drafts; and

2.3.1.5 be installed according to the manufacturers instructions.

2.4 Air-to-Air Heat Exchangers

2.4.1 Air-to-air heat exchangers shall:

2.4.1.1 Provide the ventilation rates in Section 2.1.1.3;

2.4.1.2 have a minimum sensible heat recovery efficiency of 65 percent at 117 cfm and 32°F for homes larger than 1300 ft² and 55 percent at 64 cfm and 32°F for houses of 1300 ft² or less as certified by the Home Ventilation Institute (HVI);

2.4.1.3 have a filter on the upstream side of the heat exchanger in both the intake and exhaust airstreams;

2.4.1.4 provide protection against ice buildup that does not disable the unit during freezing weather; and

2.4.1.5. be installed according to manufacturer's instructions.

2.5 Other Mechanical Ventilation Systems

2.5.1 Other mechanical ventilation systems meeting the Site Built or Manufactured Housing Super Good Cents specifications may be used if approved by Bonneville.

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